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Liquid Helium Level Indicator and Automatic Level Control

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Summary

This is a method of monitoring a liquid helium level using a superconducting probe in a helium vessel. The level measurement is made by sensing the probe voltage with an offset or inversion compensation OP Amp. The output is then fed to an OP Amp in a gain set to convert a volt per inch reading from the probe to a centimeter reading. The reading can be made directly on a D.V.M. The output to the D.V.M. is also used to drive Hi-Lo comparators for level alarms and automatic level control.

Introduction

One of the main requirements with using liquid helium is to know the liquid level in the vessel. The specific problem was to monitor liquid helium in a hydrogen jet target in use at the Internal Target Area. Because of the different cryopumping surfaces in the target vessel it was very desirable to know as close as possible the level of the liquid, particularly in three areas. First, it is necessary to know when the vessel starts to take liquid; second, when the liquid is above the critical cryo-trapping surfaces, which determines the point of a sublimation; and third, when the vessel is full to the point of liquid being forced out "O" ring sealed vent lines.

CKT. Components

A flexible type American Magnetic linear liquid helium probe is used in the helium vessel.

The constant current source can be made from one of two different methods. The method used, as shown in Fig. 2, has a full wave bridge feeding an OP Amp with the output to an open collector NPN transistor. With the other method the bridge feeds a National Semiconductor voltage regulator set up in a current source mode.

The conversion Amp section consists of two LH0041J OP Amps. The first OP Amp is used to obtain an offset voltage and set zero. The second OP Amp determines circuit gain.

The digital voltmeter is a Weston Model 1230 panel meter.

The Hi-Lo alarm circuitry has two LM311 comparators and a

75453 open collector driver. Reference voltages to the comparator are from IN740 10V zeners. The alarms are solid state audio indicators by Projects Unlimited.

The automatic level control is a duplicate of the alarm circuit components except that the outputs of the 453 driver goes to two 6 volt Sigma relays.

Operation

The constant current source must provide to the probe a constant 70 ma. Because of the varying current requirements of different length probes, the current source has to be adjustable from near zero to 140 ma. This capability, along with offset adjust and variable gain in the OP Amp section, provides the versatility necessary for the unit to be used with different lengths and specially made probes with nonstandard parameters.

The current source has output terminals for a chart recorder. Because it can be critical to know the level of liquid helium in a vessel, the reading at this output can provide a direct level indication when the voltage is correlated to the voltage per inch parameter of the probe in use. In the event of the failure of any critical part of the controller circuitry this can be a valuable backup whereby a reading can still be obtained.

The American Magnetics probe used in this particular application is approximately 50 inches long. When the probe is not in liquid helium it will read a maximum voltage of approximately 0.9 volts per inch. As it becomes immersed in liquid the voltage decreases linearly. Therefore, there is an inverse relationship.

As the liquid level increases the probe voltage decreases.

The voltage from the probe is sent to a voltage divider, Fig. 2, where it is reduced by a factor of ten. This voltage is received by the first OP Amp. This stage has unity gain with an offset adjustment. Because the probe voltage decreases as the liquid He level increases and is maximum with no liquid, the offset will start the voltage at a zero reference level and increase in magnitude from this point. Hence, it is used to set zero.

The second stage has a gain adjustable to times five. The readout in this application needs to be in centimeters; therefore, the gain is set to convert inches to centimeters. If the probe was to be totally immersed, the gain would be 2.540. If any fraction of the probe is not to be in liquid the gain is calculated and set accordingly. A more practical method is to let the He vessel fill until the readout does not increase anymore, then set the gain to the known depth, in cm., of the vessel. This is the set maximum control (Fig. 2). By switching to a reference voltage after the gain is set, a reading for maximum or full can be obtained. This set maximum reading eliminates the need to recalculate or refill the vessel. The output of the last OP Amp is fed to a Weston D.V.M.

The amplifier output also feeds the alarm and level control circuits. The Hi-Lo level alarm circuit consists of two LM311 comparators with an adjustable reference voltage at the inverting input of one, and a second adjustable reference voltage at the non-inverting input of the other comparator. One voltage is set for a maximum and the other for minimum. The other inputs

to the comparators receive simultaneously the voltage level from the amplifier stage. When the amplifier voltage reaches a maximum or minimum voltage reference the appropriate comparator changes its output level. The comparator outputs go to the input of a 75453 dual pos. "OR" driver. This driver in turn drives a solid state alarm.

The automatic level control circuit is a duplicate of the alarm circuit except the driver outputs go to relays. There are two relays, one slaved to the other. The relays control power to a helium dewar solenoid used to fill the helium vessel.

Because the circuitry has ample adjustment, it can be used with a wide range of parameters.

Acknowledgements

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Block Diagram - Liquid Level Controller

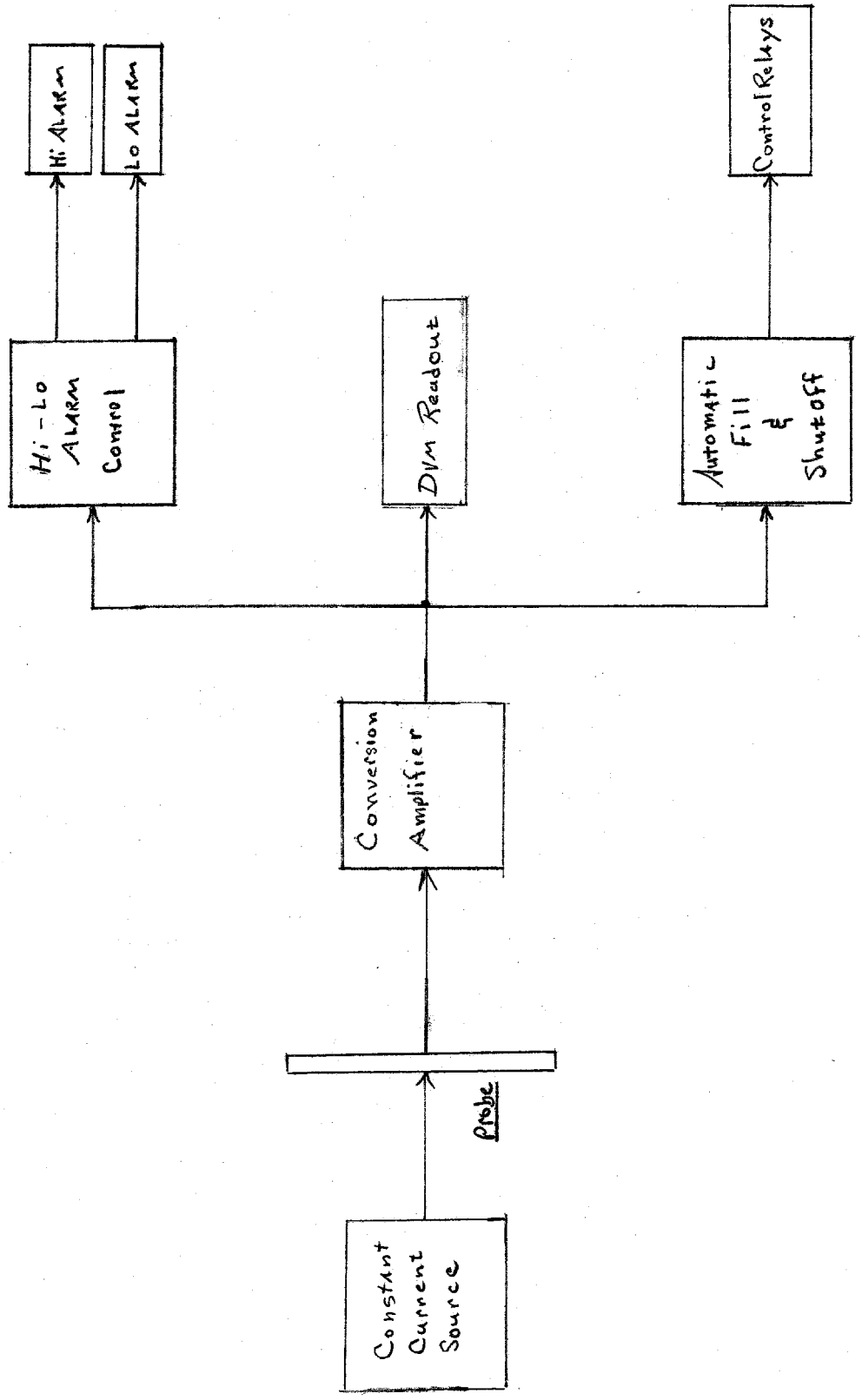

Fig. 1

ENGINEERING NOTE	INTERNAL TARGET	N2 Jet	221074	1 OF 1

SUBJECT

Liquid Level Controller

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DATE: 22 OCT 74

REVISION DATE:

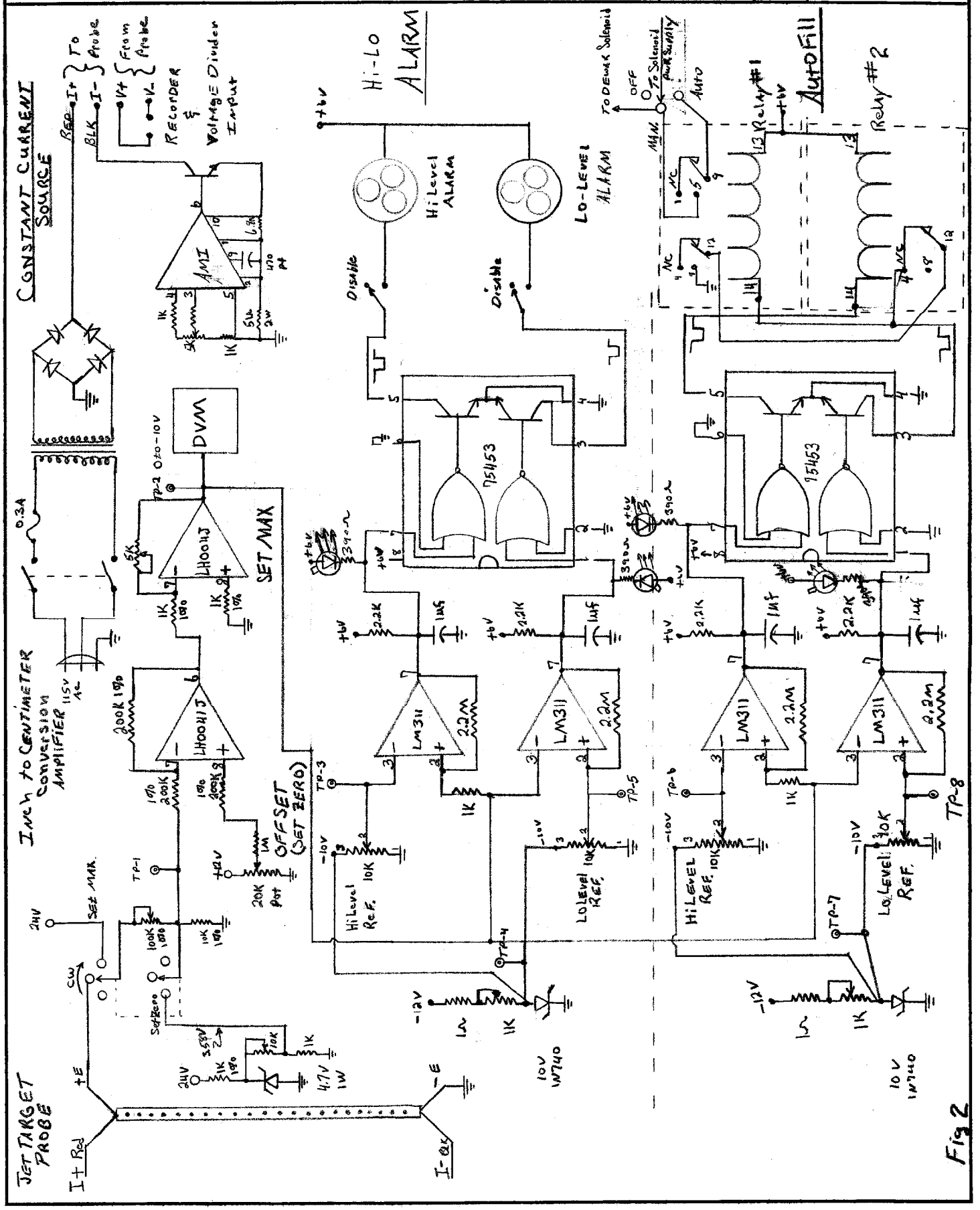

Fig 2